ATTACHMENT 4.9.3

SMOKE TESTING PROCEDURE

One of the field tasks performed in a sewer system evaluation is to locate I/I sources by rainfall simulation. Several techniques can be utilized to identify sections of sewers which may exhibit I/I during a heavy rainfall. Infiltration/inflow sources that are identified by rainfall simulation techniques include the following:

- Roof leader, cellar, yard and area drains, and foundation drains
- Abandoned building sewers, faulty connections, defective cleanouts, and storm sewers
- Cross connections between sanitary sewers and storm water drainage systems
- Storm sewer sections, stream sections, ditch sections and pending areas which may cause infiltration/inflow
- Structurally damaged sewers and manholes

Smoke testing is a relatively inexpensive and quick method detecting infiltration/inflow sources in sewer systems. The method is best used to detect inflow sources such as roof leaders, cellar, yard and area drains, foundation drains, abandoned building sewers, faulty connections, illegal connections, and storm water drainage system cross connections. It can also be utilized to detect structural damages and leaking joints in sewer pipes and overflow points in sewer systems.

This section will detail smoke testing specifications. Besides being an identification tool, smoke testing can also be utilized in conjunction with flow measurements to quantify the infiltration/inflow from each of the identified sources.

Many of the tests are performed on private property. Thus, it is essential to obtain full cooperation of the property owners. Before smoke testing, owners should be notified approximately 1-14 days in advance of the test with an explanation of the nature of the tests.

Sewer lines which contain water traps or sags may prevent smoke from passing through and result in false conclusions. Similarly, smoke will not pass through sewer sections that are flowing full. The method will not be effective in detecting structural damages and leaking joints in buried sewers and service connections when soil is saturated, frozen, or snow covered. Under these conditions, smoke will not penetrate

the ground even though there are cracks or leaking joints. Rain and snowy days are not suitable for smoke testing. Heavy rainfall may require delaying smoke testing for several days until low groundwater levels are reached. The test should not be performed on windy days when smoke coming out of the ground may be blown away before visual detection can be performed.

Results from smoke testing should be analyzed carefully. Positive findings definitely indicate existence of infiltration/inflow sources. Negative findings, however, may not prove that problems do not exist.

EQUIPMENT

The following equipment is needed to conduct smoke testing:

1. Smoke bombs
2. Smoke blower (2 minimum with available spare)
3. Camera and film
4. Sandbags and plugs
5. Safety cones
6. Measuring wheel
7. Safety glasses
8. Lighter

Superior Signal Co., Inc. Spotswood, New Jersey, manufactures smoke bombs. A 3-minute or 5-minute smoke bomb should be used depending on the time required to properly inspect the entire perimeter of each residence. A small number of five minute bombs can be ordered for special cases, but recent price increases for 5-minute bombs have made it cost-effective to use two 3-minute bombs on long segments. The smoke blower shall be gasoline driven with a minimum capacity of 1500 cfm. A spare blower should be readily available because of the potential for blower breakdown.

PRELIMINARY WORK

Prior to smoke testing, advance notice to the public must be made to minimize complications from false fire alarms, panic, and irate citizens. A press release within 30 days of test initiation explaining the nature and purpose of the smoke testing is issued. The client can usually assist in having the press release published in a local newspaper as a public notice. The press release is then followed up by door-to-door notices within two weeks of the actual work. An example of a press release is shown on Exhibit ST-2. An example of a door-to-door notice is shown on Exhibit ST-3.

FIELD PROCEDURE

Each day of smoke testing the fire department must be notified before smoke testing begins of scheduled work for the day and the general area of testing. Upon

completion of each days testing, the fire department should be notified that work is terminating for that particular day. In some cases, the fire department may request that a two-way radio be carried with the crew.

Special care must be taken to ensure that hospitals, nursing homes, and schools are aware of the smoke test. These institutions must be notified the day of testing no less than 15 minutes prior to the actual test.

Intensified smoke testing techniques will be used which will consist of two blowers operating for each line segment tested. Blowers must be placed on each manhole of the line segment being tested. Only one line segment should be tested at a time except short line segments (75 feet or less) which may be included with the test of another line segment. A blower must always be placed on the extreme upstream and downstream manhole for each test section.

If manholes are in the street or in a driveway, adequate safety cones must be placed to redirect traffic with placement of blowers clearly visible. In busy areas, additional personnel must be available for traffic control.

Plugs or sandbags are placed in the upstream and downstream lines in all branch lines entering manholes in the test section. A watertight seal is not necessary or recommended since only enough blockage to restrict smoke from leaving the test section is required. Care must be taken in blocking the downstream line to insure that a water head capable of pushing the plug downstream does not develop. This could result in a line blockage requiring several hours and significant cost to correct. In many situations, a safety cone inserted in the pipe section provides adequate restriction to smoke flow with minimum placement difficulties. In large diameter lines (21 inches or larger), baffles should be placed against the face of the outgoing pipe and above the flow line to restrict smoke passage. While plugs are being placed, one person measures the length of each line segment to be smoked with a measuring wheel. When all plugs are secure, blowers are placed on top of the open manholes and started. See the site survey section for procedures for measuring line segments. When all blowers are running smoke bombs are simultaneously ignited and placed so that smoke is forced into the sewer section under test.

The front, back and side of residences, storm manholes, inlets, and the surface along the main sewer line should be checked for the presence of smoke. During the testing, the following observations should be recorded for each line segment:

1. Location of line segment
2. Location of observed smoke leaks recorded at:
   a. Curb

   b. Sidewalk
   c. Buffalo box location
   d. Cleanout
   e. Building lateral, transition joint, front, side or rear yard
   f. Driveway area, patio, window well or stairwell drain
   g. Downspouts
   h. Building front, side or rear
   i. Building interior (resident must inform inspector)
3. Location of smoke observed from stormwater conveyance systems
4. Location of smoke along a main sewer line

Each smoke source is to be identified by means of a sketch showing location and description of smoke intensity. The sketch should include line segment, flow direction, North arrow, street name, building address (if applicable), and smoke location relative to an identifiable object. Where appropriate, the drainage area for each inflow source is estimated. In addition to drainage area, the drainage area should be identified as paved or nonpaved. A typical location by smoke source is given in Figure ST-1.

During testing, if a resident informs a crew member that smoke entered a building then a crew member must:

1. Apologize for the inconvenience, explain that the smoke is harmless and will quickly dissipate.
2. Inquire as to the source of the smoke. If the resident knows the source, then they are to be told how to plug the defect (for example, pour water in the drain, pour vegetable oil in the drain (vegetable oil will not evaporate), call a plumber, etc.). If the source is unknown, then a brief inspection of the premises is made (with the approval of the resident) in an attempt to locate the source.
3. A standard letter explaining the smoke conditions is given to the resident (see Exhibit ST-4).

   A Field Crew Daily Work Report must be turned in to the Project Manager of field supervision stating the number of lineal feet of sewer smoked and the number of smoke bombs used, along with other pertinent comments.

SMOKE TEST FORM STANDARDS

Entry Number	
Project No.:	The project number should be clearly stated.
Project Name:	The project name should be stated. Project initials or an abbreviated name may be acceptable. The form can be stamped with a project name stamp during office review.
By:	The inspector numbers of the crew conducting the smoke testing should be entered.
Date:	The date should be indicated.
1) Line Segment:	The line segment on the map should be entered.
2) Street:	Indicate the name of the street closest to the line segment with respect to building address, intersections, or other manholes.
3) Precipitation:	As observed.
4) Ground:	As observed.
5) Smoke Leaks:	If could not smoke explain. (For example, line surcharged, sagged, etc.). If private sector sources are found, enter only those house addresses with sources. The house numbers entered will be assigned to the street entered under Item Number 2. If private sector sources are identified on more than one street (for example, when the sewer is in an easement between two streets) write the name of the second street beside the corresponding street address.
6) Curb:	Smoke appears through crack in curb or along edge of curb.
7) Sidewalk:	Smoke appears through crack in sidewalk or along edge of sidewalk.
8) Buffalo Box:	Smoke appears usually in grass between sidewalk and curb.
9) Cleanout:	Smoke appears from pipe in yard. This would be on a line between the house and sanitary sewer pipe.
10) Building Lateral:	Several smoke sources appear in the yard in a straight line between building and sanitary sewer.
11) Transition Joint:	One source of smoke appears near the building that is on same line described in Line 10.
12) Front Yard:	Any source of smoke that appears in the front yard away from the building.
13) Side Yard:	Any source of smoke that appears in the side yard(s)

away from the building.

14) Rear Yard: Any source of smoke that appears in the rear yard away from the building.

15) Driveway Drain: A drain for the driveway.

16) Area Drain: Smoke appears from a pipe in the yard near the ground surface, usually in a depressed area.

17) Patio Drain: A drain for the patio.

18) Window Well Drain: A drain for a window well.

19) Stairwell Drain: A drain for an exterior stairwell.

20) Downspouts: Smoke appears from downspouts connected underground. If smoke appears at the foundation where a downspout was previously connected, this should be noted under comments with an estimate of the drainage area, if any, and the reason for smoke (e.g. cracked plug).

21) Building Front: Smoke appears form downspouts connected underground. If smoke appears at the foundation where a downspout was previously connected, this should be noted under comments with an estimate of the drainage area, if any, and the reason for smoke (e.g. cracked plug).

22) Building Side: Smoke appears along the building side(s), in one or several places, next to the foundation.

23) Building Rear: Smoke appears along the building rear, in one or several places, next to the foundation.

24) Interior Crawl Space Drain: Smoke appears from a drain in the crawl space of a building. (The homeowner must inform the inspector).

25) Building Interior: A smoke source where smoke enters the habitable area (including the basement and garage) of a building. This source should be described under comments.

Drainage Area (SF) Note the approximate area drained of defects such as cleanouts and all area drains, and mark paved or non-paved. This information is used by the project engineer to estimate inflow for each defect.

26) Indications of Cross Connections: Enter appropriate box, draw sketch and take photograph. Note the picture number and roll number for each individual defect photographed.

27) Recommended for Dye Water Flooding: If a cross connection exists or main line smoke is observed, mark "YES".

28) Smoke Along Main Sewer Line: If smoke along main sewer line is greater than 5' from nearest manhole mark "YES".

29) Recommended for TV Inspection: If smoke is observed along main sewer line, or if a cross connection exists that can not be observed from a manhole, mark "YES".

30) Length: _____ Enter the length of the line segment to the nearest foot

	Ft.	as measured with the measuring wheel.
31)	Defective Frame Seal at Manhole:	If smoke appears from the frame seal of a manhole on the tested line segment enter the manhole number.
	Sketch and Comments:	Indications of lateral defects, cleanouts, and private manholes should be sketched and the distance noted from a stationary object. Cleanouts should be noted as above/below grade and the drainage area should be indicated in the space provided above. Note when vent smoke is weak as an indication of pipe sags, blockages, etc.

Attached are the flowing forms for reference:

Exhibit ST-1 — Smoke Test Inspection Form
Exhibit ST-2 — Letter to Residents Regarding Smoke Testing
Exhibit ST-3 — Door-to-Door Notice
Exhibit ST-4 — Letter to Resident Having Smoke From Test in Home

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Smoke Test Inspection Form

Project Name: _____ Project No. RJN - _____ By: _____

Client Segment: _____ _____ Date: _____

1. Line Segment ( ) _____ ( ) _____

2. Street Name _____

3. Ground: 1 ☐ Dry 2 ☐ Wet 3 ☐ Standing Water

4. Smoke leaks at or along: A. ☐ Could Not Smoke (explain under comments)
B. ☐ No Building Leads for this segment

	Leak No. ____ Street No. & Name	Leak No. ____ Street No. & Name	Leak No. ____ Street No. & Name	Leak No. ____ Street No. & Name	Leak No. ____ Street No. & Name
1. Curb	6 ☐	6 ☐	6 ☐	6 ☐	6 ☐
2. Sidewalk	7 ☐	7 ☐	7 ☐	7 ☐	7 ☐
3. Water Meter	8 ☐	8 ☐	8 ☐	8 ☐	8 ☐
4. Public Cleanout - Broken	9 ☐	9 ☐	9 ☐	9 ☐	9 ☐
5. Public Cleanout - Missing Cap	10 ☐	10 ☐	10 ☐	10 ☐	10 ☐
6. Private Cleanout - Broken	11 ☐	11 ☐	11 ☐	11 ☐	11 ☐
7. Public Cleanout - Missing Cap	12 ☐	12 ☐	12 ☐	12 ☐	12 ☐
8. Private Building Lateral	13 ☐	13 ☐	13 ☐	13 ☐	13 ☐
9. Public Building Lateral	14 ☐	14 ☐	14 ☐	14 ☐	14 ☐
10. Rear Yard	15 ☐	15 ☐	15 ☐	15 ☐	15 ☐
11. Driveway Drain	16 ☐	16 ☐	16 ☐	16 ☐	16 ☐
12. Area Drain	17 ☐	17 ☐	17 ☐	17 ☐	17 ☐
13. Patio Drain	18 ☐	18 ☐	18 ☐	18 ☐	18 ☐
14. Window Well Drain	19 ☐	19 ☐	19 ☐	19 ☐	19 ☐
15. Stairwell Drain	20 ☐	20 ☐	20 ☐	20 ☐	20 ☐
16. Downspouts	21 ☐	21 ☐	21 ☐	21 ☐	21 ☐
17. Building Front	22 ☐	22 ☐	22 ☐	22 ☐	22 ☐
18. Building Side	23 ☐	23 ☐	23 ☐	23 ☐	23 ☐
19. Building Rear	24 ☐	24 ☐	24 ☐	24 ☐	24 ☐
20. Interior Crawl Space Drain	25 ☐	25 ☐	25 ☐	25 ☐	25 ☐
21. Building Interior	26 ☐	26 ☐	26 ☐	26 ☐	26 ☐
22. Smoke Intensity	L ☐ M ☐ H ☐	L ☐ M ☐ H ☐	L ☐ M ☐ H ☐	L ☐ M ☐ H ☐	L ☐ M ☐ H ☐
Drainage Area (SF)	_____	_____	_____	_____	_____

23. Indications of Cross Connections Smoke leaks at or along (circle one): 1. Catch Basin 2. Storm Ditch 3. Storm Manhole 4. Storm Sewer Cleanout 5. Other 6. None

24. Recommended for dyed water flooding: ☐ Yes ☐ NO Location(s) _____

Indications of Main Sewer Defects

25. smoke along sewer line ☐ Yes ☐ NO 26. Length _____ Ft.

27. Recommended for TV inspection ☐ Yes ☐ NO 28. Smoke at Upstream Manhole: ☐ Yes ☐ NO

SKETCH:

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EXHIBIT ST-1

(Draft to be typed on City letterhead)

Dear _____

The Village of Glencoe has begun a program to locate and rehabilitate defects in the sanitary sewers which allow extraneous rainfall and groundwater infiltration to enter the sanitary sewers. This extraneous water results in sewer surcharging and basement backups during periods of rainfall. The field investigation is being conducted by the RJN Group of Wheaton, Illinois and will include smoke testing the sanitary sewers.

There are four study areas: the first is along Franklin Road, Sylvan Road, Meadow Road, and Forest Avenue. The second is in the North School area along Old Elm Lane, Elm Court, Terrace Court, Carol Lane, Park Place and Linda Lane. The third area comprises the area north of Dundee Road bounded by Elm Ridge Drive, Westley Road, and Longmeadow Lane. It also includes Northwood Drive. The fourth area is bounded by Dundee Road to the north, Forest Way to the west, Chestnut to the south, and Elm Place to the east.

The smoke testing technique is a simple means of locating openings in the sewer system that allow surface rainwater runoff to enter the sewers. The technique consists of forcing a large volume of air combined with smoke into the sewer lines where it follows the path of intruding water in reverse to the surface, disclosing the location of the leaks. Smoke will appear at the surface where there are leaks in the sewer line, cross connections to the storm sewer system, connected drains such as roof, patio and footing drains.

The smoke used is non-toxic, harmless, has no odor, creates no fire hazard, leaves no residue and quickly dissipates.

Smoke should not enter buildings unless there is defective plumbing or dried up drain traps. If you seldom use drains and you want to reduce the chance of smoke entering your building, pour water in the drains to fill the traps. If smoke is found in the building, you should open windows and the smoke will dissipate quickly. Also notify the testing personnel from RJN Group working in the neighborhood that smoke has been found.

Weather permitting the smoke testing is scheduled to begin _____ and be completed _____, 2001.

Signs will be posted at major intersections advising the residents of the testing during the week preceding the start of the smoke testing.

If you have any questions or would like additional information please call Christine Van Dornick, Village Engineer, at (847) 835-4111 or visit the Village website at www.glencoevillage.org.

Very truly yours,

David C. Mau, P.E.
Director of Public Works

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EXHIBIT ST-2

NOTICE

In the next few days, inspection crews will be conducting a physical survey of a portion of the City of Dallas sanitary sewer system. This study will involve the opening and entering of manholes in the streets and easements. An important task of the survey will be the "SMOKE TESTING" of the sewer lines to locate obstructions and defects in the sewer system. The smoke that you see coming from the vent stacks on houses or holes in the ground is NON-TOXIC, HARMLESS AND CREATES NO FIRE HAZARD. The smoke should not enter your home unless you have defective plumbing or dried up drain traps. If this occurs, you should consult your licensed plumber. In any event, if the harmless smoke can enter through faulty plumbing, the potential exists for dangerous sewer gases to enter your home or establishment. Should smoke enter your building or structure, you may contact a member of the smoke testing crew working in the area. If you have seldom used drains, please pour water in the drain to fill the trap, which will prevent smoke from entering there. Drain traps should always be filled with water to prevent sewer gases or odors from entering the building.

Some sewer lines and manholes may be located on the backyard easement property line. Whenever these lines require investigation, members of the inspection crews will need access to the easements for sewer lines and manholes. Dallas Water Utilities personnel are uniformed and carry identification badges. Homeowners do not need to be home and AT NO TIME WILL FIELD CREWS HAVE TO ENTER YOUR BUSINESS OR RESIDENCE.

We anticipate the smoke testing will require a few hours in your area. Your cooperation is appreciated. The information gained from this study will be used to improve your sewer services.

Coordination of effort will be between RJN Group, Inc. and Dallas Water Utilities.

If you need special assistance or would like more information, please contact RJN Group, Inc. at (972)437-4300 or visit our website at www.rjn.com.

RJN

Dallas Water Utilities

EXHIBIT ST-3

SMOKE TESTING OF SEWERS

Dear Resident:

We regret that smoke entered your building during this important inspection of the sewers. The smoke is non-toxic and will not stain or damage your property.

Smoke can enter a building through an open line that is not protected by a drain trap filled with water. A dry drain trap can allow sewer gas to enter the building along the same path. Sewer gas is produced by chemical and biological reduction of waste material in the sewer. This gas generally exhibits foul odors and can be hazardous.

We recommend that you keep all drains traps filled with water on all the drains in your home. If you have additional questions, please call the sewer department for your community.

EXHIBIT ST-4

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